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OF THE

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TWELFTH ANNUAL MEETING.

ADDRESS OF THE PRESIDENT.

FORENSIC MICROSCOPY; or, THE MICROSCOPE IN ITS LEGAL RELATIONS.

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The occasion which brings us together at this the Twelfth Annual Meeting of our National Organization is one of unusual interest. Ours is a society composed of persons representing every department of natural science, diligent seekers after truths, penetrating more and more, as the years roll on, the innermost secrets of nature, and lifting the shrouding veil of mystery from the dogmas of old; its members engaged in special pursuits, apparently widely separated, into which, partly from taste, partly from environment, we have as individuals been led, yet united in the one distinctive field of requiring the aid of that king of instruments, the microscope, in our varied and multitudinous investigations.

Coming from widely-separated parts of a great country, we meet once a year to glean from one another the experience of a twelvemonth; to acquire in a few days, through such interchange of ideas and thought, a practical knowledge which might otherwise necessitate years of unaided individual work to encompass. It is surprising that the need of such an organization should ever have been

questioned; surprising too, that its necessity was not sooner appreciated.

No instrument yet devised by the ingenuity of man equals the microscope in its universal application to research in the broad domain of science, and this evening I propose to call your attention in a brief way to some of its special relations to jurisprudence.

Taking advantage of that subtle power of the human mind to ignore space, let us for a moment glance into the past; that we may better appreciate the present status of science; briefly review some of its victories over superstition and ignorance, and recall to mind those who, having gone before, have laid much of the foundation for that edifice wherein rapidly-increasing knowledge is enlightening its devoted students.

Medical jurisprudence, to which science the microscope in its legal relations is most closely allied, dates from the early part of the seventeenth century, when the first treatise on forensic medicine appeared; a work written by Zacchias, then one of the Pope's physicians. In it he devoted chapters to prophecy, miracle, sorcery, torture and kindred subjects. Suffice it to say, this once able work by the father of legal medicine is no longer cited as an authority. The new-born science, receiving little encouragement in Italy, was soon transplanted to Germany, where it was carefully nurtured under government protection until the favorable legislation of 1532 made it obligatory on courts to take the evidence of medical men in all cases involving medico-legal questions. From that time until the present, Germany has held her supremacy in forensic medicine. The work of Zacchias was superceded as early as 1730 by the justly-celebrated productions of Albertus, Valentini, and Teichmeyer.

France, about 1600, enacted laws similar to those then in force in Germany, and made considerable progress in the science until 1692, when medico-legal offices became hereditary and corrupt, and remained so until the French Revolution. Since 1803 France has required of her medical experts (who, by the way, are appointed by the court, and not as in this country retained by counsel) to be graduated in medicine, and also to pass a rigid examination on medical jurisprudence, in which study they are presumed to have had special training.

No direct application of the microscope to questions of law or of legal medicine was made until about 1835, since which time it has been used repeatedly in convicting the guilty and acquitting the innocent. No longer are we obliged to resort to expedients taught by Albertus in 1726, such as, that the victim's wounds would open and bleed afresh in the presence of the murderer; or the time-honored custom of watching the effect upon a suspected criminal as he touched the dead body of his supposed victim—the latter test having been used until well into the present century.

As the greatest advances made in placing medicine as a science on a proper foundation date from the application of the microscope to physiological investigations, it is not strange we should find it at the present time occupying a large and important field in medico-legal research.

At first, the microscope in its legal relations was confined to a few questions in criminal law. With the improvements in modern lenses, with the new and perfected means of determining minute measurements, with the adaption of the spectroscope and other accessories, it has assumed such importance in both criminal and civil law as to justify the coining of the term Forensic-Microscopy. Although the microscope has for a number of years played an important part in many noted criminal cases, its proper relation to law, and especially to medical jurisprudence, is little understood. By many its powers are overestimated, while others underrate its value, or even cast aside as worthless all testimony relating to the results obtained through its use.

It is an unfortunate though existing condition which permits a person to testify as an expert in branches where he has but little more knowledge than his hearers. Partly for this cause discredit has been thrown upon the whole field of expert testimony in this country. Physicians as a class are noted for never agreeing with one another, especially when called upon to testify as witnesses. It is proverbial that an equal number of medical experts may be obtained to express themselves on opposing sides. This, however, relates purely to their opinions or their respective interpretation of facts. Such disagreement is not confined to the medical profession, but invades all branches of expert testimony. In cases involving

questions of mechanics and physics, it is of frequent occurrence for expert machinists, electricians, and others, to express exactly opposite opinions; and a notable example of this may be found in the voluminous testimony recently taken in the State of New York on the question of executing criminals by electricity.

Where, however, two or more persons expert in the use of the microscope are called upon to testify, there should be no disagreement as to the results of any examination they may make. Thus, for example, in the examination of a stain, if blood-corpuscles are found, that should be determined equally well by each. If measured, their measurements should correspond exactly. There should be no difference on these matters of fact, though their opinions as to how the blood came there, how long it has been there, or like questions, may be honestly opposed.

In the broad field of chemistry and toxicology the microscope is not only an important means by which to determine the composition of fluids and solids, but is frequently used to corroborate ordinary tests made in the chemical laboratory.

It is not many years since that deaths from poisoning were surrounded by a fear and dread scarcely appreciable at the present day. Then, the action of poisons and their means of detection were unknown. So great an atmosphere of suspicion and dread surrounded a sudden and inexplicable death that the grossest legal abuses prevailed. Severe punishments were inflicted upon persons suspected of having committed murder by poisoning, and those convicted in England were for a long period boiled alive, and in France burned at the stake even so late as 1791. With modern methods of investigation a knowledge of poisons has been obtained, and methods introduced for their detection, so perfect as to render the fear of discovery greater than the fearful and indescribable dread once experienced of being the victim of a mysterious death.

With a special form of the modern microscope made for chemical work, so arranged that the objective is below the stage, where it is protected from the corrosive action of reagents, qualitative chemical analysis of minute quantities may be conducted with ease and accuracy, the reactions and crystalline deposits of different chemical combinations being observed through the instrument.

Although the inverted microscope has been known for some years in the forms issued by M. Nachet, it has been used but little on account of its limited scope and unsatisfactory definition as compared with the usual upright model. Through the skill and ingenuity of one of the members of this Society, Mr. Edward Bausch, the instrument has been greatly modified and improved, and introduced in the form of a combined inverted and vertical microscope. The practical application of the present model extends the field it was intended to occupy, and renders easy micro-chemical investigations heretofore impossible, or requiring the most delicate and tedious manipulation.

The greatest advance made in modern legal chemistry was through the brilliant achievements of Bunsen and Kirchhoff in 1859, by which we are enabled, through the means of the spectroscope, to identify with unerring accuracy not only the elementary forms of matter, but many compounds, and in quantities so minute as to be beyond the reach of all other known methods of analysis. With the great activity characteristic of modern science, no sooner was the wonderful capacity of the microscope appreciated than efforts were made to devise a combination whereby it could be utilized in microscopical research. Largely by the efforts of Mr. H. C. Sorby this was accomplished and the micro-spectroscope introduced, through which new and important discoveries have since been made, especially in the field of forensic microscopy. The first notable improvement in micro spectroscopes was a modification by Zeiss, of Jena, who devised an arrangement whereby the direct-vision prism may be turned one side and the slit opened, thus enabling the object under inspection to be accurately focused.

A variety of scales have been used for mapping out and measuring the absorption bands, the best being that in the Zeiss instrument referred to, where the scale is ruled to read in wave lengths. In determining the exact location of the absorption bands it is essential that the eye should be kept in a fixed position, as the least motion on the part of the observer alters the apparent relation of the bands to the bright lines of the scale, to an extent sufficient to confound, for example, a spectrum of blood with that of some other red fluid. Prof. Moses C. White, of Yale College, a member

of this Society, who has had a long and varied experience in the use of the microscope in medico-legal cases, a few years since devised and perfected a micro-spectroscope which entirely overcomes the requirement of holding the eye fixedly, and renders the practical utility of this feature of the instrument equal to its theoretical value.

All the best forms of modern micro-spectroscopes are provided with an arrangement whereby the spectrum of a known solution may be examined in direct comparison with the one under observation. The great delicacy of this instrument, and the importance of its application in legal examinations, can hardly be overestimated. Mr. Sorby and others have claimed they were able to reveal the presence of a single blood-corpuscle by its spectrum, and their observations are confirmed by Prof. Theodore G. Wormley, of the University of Pennsylvania. The delicacy of the test may be better understood when we remember that the estimated weight of a human blood-corpuscle is about one five hundred-millionth of a grain.

By the aid of these instruments, and through discoveries already made, the foundation has been laid for a branch of investigation in criminal cases which will at no distant day be better understood. I refer to the critical and systematic study of dyes and other substances used in the manufacture of textile fabrics. It frequently happens that wool, cotton, and other fibers are found on murderous weapons submitted to experts for examination. These often contain artificial coloring-matter, which may or may not correspond to similar fibers in the clothing worn by the victim or the accused. In an examination of a suspected blood stain, involving the question of crime, the micro-spectroscope may be used to corroborate other tests. While it enables us to discriminate between the coloring principles of blood and other fluids, it does not, unfortunately, assist in distinguishing between the blood of different animals.

Considerable attention has been given of late to the microscopical examination of handwriting, both in criminal and civil cases. Differing from the views of many writers on the subject, I consider the instrument of no aid in forming an opinion as to the author of a given specimen of penmanship, its value being confined to the

determination of alterations and changes made in the original. The slightest derangement in the fibers on the finished surface of the paper cannot be restored by the most skillful forgers. It is impossible to make an erasure of either pencil, pen and ink, or printed lines, which the microscope will not detect.

One of the commonest methods employed in imitating handwriting is to first make a pencil sketch or tracing, which is afterward inked and the pencil marks erased. No matter how delicately this erasure is performed, under the proper lens the surface of the paper will disclose when this method has been employed. Not only can the abraded surface be easily distinguished, but particles of graphite are almost invariably found. When the original has been obliterated by bleaching with chemicals sometimes used for that purpose, the consequent stain removed and other words substituted, the microscope furnishes a sure and ready means of detection.

A material change in a legal instrument may sometimes be accomplished by the addition of a few strokes of the pen here and there, which would escape observation by the most critical eye, yet when viewed through a glass of adequate power their true character might be revealed.

Prof. Albert McCalla, in his presidential address delivered before this Society at its Chicago meeting, says: "The microscope is an unerring detective." To illustrate the truth of this statement, and to show the numerous and unexpected roads through which legal microscopy leads one, I would call attention to an interesting case coming under my observation several years since:

A burglary had been committed. Prior to the discovery of the crime two men were arrested by the police as suspicious characters. When the theft was reported, suspicion immediately fell upon the prisoners, though nothing could be found upon their persons to connect them with the deed. As a last resort their shoes were submitted to a microscopical examination, to see if it could possibly reveal the desired clue. These shoes, though by no means microscopic themselves, furnished sufficient material for the most enthusiastic scientist. Those who have ever examined similar articles, which have been occupied for months in collecting specimens, can appreciate the food for scientific thought thus accumulated. Min-

gled with a vast assortment of debris, between the soles and uppers, were found little patches of wheat flour. It was then learned that entrance had been effected through a pantry window, and the men in their operations had upset a pan of flour standing on a shelf near by. Although when first charged with the offense they had denied all knowledge of it, yet when the result of the microscopical examination was made known they confessed their guilt.

Another instance in which a crime was detected and demonstrated solely by the aid of the microscope is worth citing: — Two elderly maiden sisters lived in a small frame house in a country village. One night their dwelling was discovered to be on fire. An alarm was immediately raised, and neighbors collected, who used every effort to subdue the flames, but without avail. The entire house with its contents was consumed. A search among the ruins revealed the charred parts of all that remained of the former occupants. The origin of the fire was a mystery. An investigation was ordered, to ascertain if possible not only its cause, but also to determine whether the sisters were burned to death, or whether murdered and the house burned to conceal the crime. Not enough remained of the bodies to throw any light upon the subject; but their hair, which was long and heavy, was found intact. This was imbedded in a pultaceous, brownish-colored mass, which I found upon microscopical examination to be composed entirely of blood which had coagulated and been partially dried by the intense heat, yet had retained sufficient moisture to preserve the hair and pieces of clothing found in the same place. Of course such an outpouring of blood must have occurred prior to death, and could not have been caused by the fire, the action of heat being to coagulate and stop its flow. Owing to the quantity of blood found with the long hair of the head, the natural inference was that the larger vessels of the neck had been cut, and the bodies afterwards burned.

The attention of an expert called upon to make a microscopical examination in a case involving a question of crime is generally directed towards determining the nature and source of the material under observation. This is frequently of animal origin. At the very outset we are met by the stubborn fact that no histological tissue is sufficiently characteristic of the particular animal from

which it is derived to enable us to determine its absolute source in all cases; and this is not strange when we consider the theory of evolution generally accepted by scientists of the present day. Indeed, we could hardly expect to find a morphological tissue which has not its counterpart in other microscopic animal or vegetable life. One form naturally blends into another in the development of species, an absolute line of demarcation in histological elements being beyond the power of the microscope to determine with our present knowledge. Lawyers, ever mindful of their clients' interests when the evidence is against them, cling to this straw with great tenacity.

In criminal cases the examination of a supposed weapon should be conducted with the greatest care, and full notes taken of every process in the operation. The weapon itself should be described, with the measurements and notes of all spots or marks which might in any way bear upon the case, and their relation one to another. It is also frequently advisable to make photographs for record and future reference. A thorough search should be made for any hairs, fibers, or other substances, which, if found, should be carefully removed for further investigation, their exact position having been previously noted, and the specimens properly marked to prevent confusion and future complications. Careful investigation of filaments thus obtained, and which are unfortunately frequently overlooked, will oftentimes reveal valuable information otherwise escaping observation.

Little of value has been written on the subject of hair in its medico-legal relations. Although nearly all treatises upon medical jurisprudence, both in the English and foreign languages, mention the subject, they are largely copied one from the other, and based upon comparatively little original research. While we may not always be able to positively determine the source of a given hair or fiber by microscopical examination alone, yet when taken in connection with other information, an existing doubt may sometimes be removed and conclusive evidence established.

In a recent case occurring in Connecticut a man was found on his barn floor mortally wounded. He remained unconscious until his death. The injuries were a fracture of the skull and several

lacerated wounds of the scalp, some extending beyond the hair-line well down on the forehead. A murder was suspected and a young man arrested for the crime. A piece of scantling some three feet long and covered with blood at one end was supposed to have been the instrument used by the assailant. On an examination of the weapon, I found among other things a number of minute downy hairs imbedded in the blood. During the subsequent trial, the defense set up was that the man had fallen from a hay-mow, striking his head upon the stick in question, thus producing the injuries. Distinct spots of blood indicative of blows were found on different sides of the club, and the defence in trying to make this evidence conform to the theory raised the question as to the origin of these minute hairs. The testimony was to the effect that they came from the forehead of the deceased. This opinion was not, however, based solely upon a microscopical examination of the hairs, but in connection with other testimony previously introduced; the query being substantially, What evidence was there to show that these minute hairs had any connection with the case, assuming the blood to have been from deceased.

The examination showed the hairs to have been torn out by violence, inasmuch as many of them still retained the bulb and bits of lacerated tissue, and the cortex was more or less torn and indented. They were found fixed under slivers of wood in locations some inches apart, and also on different faces of the scantling. There being no similar hairs on any portion of the scalp where the wounds occurred, except the forehead, where they are plentiful, it is obvious they must have come from the latter location. The hairs were embedded in groups too widely separated to conform to the theory that they were produced by a fall or by a single blow, when considered together with the surgical relation of the wounds. A strong effort was made to throw doubt on the value of this testimony and confuse the jury, on the ground that the hairs of some animals measured the same in diameter as these referred to, and that it was therefore impossible to discriminate between them microscopically. On this account it was claimed that the hairs might easily have been from another source, the one on which the greatest stress was laid being the fine downy hairs from a mouse. Any person familiar with

the microscopical appearance of hair from rodents will appreciate the absurdity of claiming a resemblance between those and the human hair in question.

In opinion-evidence relating to hair (and the same may be said of nearly all other animal tissue), the truth can often be better reached by exclusion than by an attempt to designate the particular animal or person from which it is derived. Microscopical differences between the hairs of various animals are as a rule far easier to determine than in the case of blood, the optical image being generally so characteristic as to sanction the exclusion of many sources without further investigation. Micrometry is of little value in diagnosing a particular hair so far as its diameter is concerned, though of aid in ascertaining the relative portions of medulla and cortex.

The cortical substance of hair is constructed of large horny cells of varying thickness, which requires considerable force or pressure to damage. Hairs torn out by violence, especially with blunt instruments, are frequently found indented or lacerated. The bulb is also frequently torn out with the shaft. The fact, however, that hair is found with its bulb intact is not conclusive proof that it was removed by violence, for numerous instances occur in which the hair falls out by natural process or disease.

Of all legal problems submitted to the microscope for solution, none has excited more interest, more painstaking original study, or more animated discussion, than the determination and differential diagnosis of blood in criminal cases. Much of the literature on the subject written but a score of years since is now of little value, and tends to confuse rather than enlighten one seeking to obtain reliable information.

Not many years ago it was claimed by some that human blood could be distinguished from that of all animals by the different size and form of its hæmin crystals, and experts have so testified. This is now used only as a corroborative test in determining the substance to be blood. The physical appearance of a blood stain varies with its age and the material on which it is found. Blood which has dried upon a polished or smooth surface, such as steel, glass, varnished wood, and such textile fabrics as silk or satins, rapidly assumes

a dark-brown color. When it happens that the stains are on mahogany or walnut furniture, they are sometimes very difficult to detect by daylight, though often easily distinguished by the dim reflected light of a candle. On white pine and other soft woods the blood retains its bright red appearance for a considerable period.

The first step in the examination of a suspected stain is to ascertain whether it is blood or not; and if blood, next, to determine if possible its source. These two problems can best be solved by aid of the microscope and micro-spectroscope. For the purpose of diagnosing the kind of blood, the microscope alone is available. The prevailing opinion among experts is that the microscopical detection of red blood-corpuscles is the only reliable evidence which should be admitted in criminal cases. Blood-corpuscles are not liable to be confounded with any other known object by a person familiar with their appearance, yet careless mistakes have occurred.

In Ohio I was once called upon to make an examination of a stain for the purpose of corroborating evidence already introduced to the effect that it was blood. All ordinary methods failed to reveal blood-corpuscles, and subsequent tests proved conclusively that it was another substance. On examining the slides prepared by the witness who had previously testified, and with his own instrument, I was surprised to find that what he had mistaken for blood-corpuscles were nothing but spots left from condensed moisture on the lower lens of his eye-piece, he never having had the object itself in focus during his entire investigation, Such a blunder could not happen to one familiar with microscopical manipulation, as a mere turning of the eye-piece, which is generally done from habit, would have exposed the error.

The red corpuscle of human blood is a small, circular, non-nucleated, biconcave disc. The same form and appearance exist in most of the mammalia, the only means of distinguishing between the two being their difference in size. The red corpuscle in man averages about $\frac{1}{3200}$ of an inch in diameter. Race, habit and environment seem to have no effect on the size or appearance of these discs. The late Dr. J. G. Richardson, of Philadelphia, during the Centennial Exhibition held in that city in 1876, examined and measured one hundred corpuscles from each of fourteen different persons

of different nationalities, and found their average diameter to be $\frac{1}{3\,2\,2\,4}$ of an inch. Selected corpuscles may measure more and others less than these figures, and for this reason it is impossible to discriminate with absolute certainty human blood from that of some animals.

Unfortunately, in the dog, one of our nost common domestic pets, the corpuscles so closely resemble those of a man that it is difficult to distinguish between them. Out of two hundred corpuscles from the blood of a man and an equal number from a dog, Dr. J. P. Treadwell found that of those measuring $\frac{1}{3\,2\,0\,0}$ of an inch, forty-six were from the man and six from the dog; of those measuring $\frac{1}{3\,3\,0\,0}$ of an inch, thirty-seven were from the man and seventeen from the dog; of those measuring $\frac{1}{3\,4\,0\,0}$ of an inch, fourteen were from the man and twenty-three from the dog. It will thus be seen that although the average human blood-corpuscle is slightly larger than that of a dog, the variations in size overlap in measurement so as to make it unsafe to express a positive opinion where the question is confined to distinguishing between human and dog's blood. The blood from the guinea-pig is still more difficult to determine in comparison with that of man.

From careful measurements of the red corpuscles in a given specimen, if found to average the same as those in man a positive opinion may be expressed that the blood did not come from the sheep, ox, horse, pig, or goat; the corpuscles in these animals being so much smaller as to render the distinction easy.

In the famous Hayden trial held in New Haven in 1879, the late Col. J. J. Woodward, M.D., when testifying on the question of blood stains, stated that in measuring twenty corpuscles from one dog, forty from another, and fifty from a third, he found their diameters greater than the recognized average in human blood. On cross-examination by the State, he, however, admitted that he had selected only the largest corpuscles for measurement. Subsequently Dr. Woodward continued his investigations and published the measurements made of red corpuscles in dog's blood, selecting, as in the Hayden trial, only the largest. This unfortunately renders his data valueless for reference as to averages.

The blood-corpuscles of all birds and reptiles are elliptical in shape and nucleated. This distinguishes them at once from the blood of a man without recourse to micrometry.

Numerous cases have been recorded where blood stains have been found on clubs alleged to have been used in murderous assaults, where it was claimed as a defence that the stick had been used for killing pigeons or chickens, and where the microscope demonstrated beyond the question of a doubt that the blood could not have come from such source.

An interesting case in my own experience is worth relating in this connection:—Two winters ago, in the far Northwest, a merchant prominent in the community in which he resided left his home one evening for the ostensible purpose of visiting his store to transact some unfinished business. Not returning home when expected, his friends became alarmed and went to look for him. On reaching his store they were startled to see everything in confusion; furniture broken and strewn about the office; the safe door open; money drawer on the floor and empty, save for a few small coins; blood spattered here and there, and every thing indicating a severe struggle, murder and robbery. Spatters of blood were traced outside into the deep snow which covered the ground; footsteps were crowded here and there, and the trail bore indications of a bleeding body having been dragged to the river not far distant, and a hole large enough to admit it chopped through the ice to the swift current below. It would be hard to conceive a stronger case of circumstantial evidence.

The man had a large sum of insurance on his life, and a prompt investigation by the insurance companies solved the mystery. A microscopical examination of the blood showed that it could not have been that of a man, for the corpuscles were elliptical in shape. A few days later the supposed deceased was captured and arrested in a city about five hundred miles distant from the scene of his disappearance. He confessed to having concocted and carried out the plot unaided; that the blood was spattered about by cutting off the heads of two chickens, which were then tied to a board and dragged through the snow to the river, where they were pushed into the hole previously cut through the ice.

Sometimes a witness is asked to give his opinion as to the probable age of a blood stain. It is generally easy to recognize a fresh specimen, though in stains but a few days old the physical appearance is frequently the same as those of months or years standing. The question of solubility has been carefully investigated for the purpose of throwing additional light on the subject. In a stain which has been dried but a few hours the blood-corpuscles are more easily restored to their original state than in an old one, but the information thus derived is not always to be depended upon. The most trustworthy information to be obtained on this subject is by ascertaining the chemical changes which have taken place in the coloring matter; *i. e.*, whether it is in the form of hæmoglobin, methemoglobin, or hæmatin. By this method one may be able to approximate the age of a given stain within certain limits, but the greatest possible caution should be used in expressing an unqualified opinion derived from any source within our present knowledge.

One of the unfortunate conditions of present scientific literature is the different systems and unreliable standards which have been taken as a basis of measurement. Most of our modern scientists have adopted the decimal of the French metric system, though a few still adhere to the English inch. In our country the English system is in common use by the masses. In the field of forensic microscopy it is necessary, therefore, that all measurements should be taken and expressed in fractions of an inch. Although it is impossible for the average juror, with his peculiar qualifications, to comprehend the fraction $\frac{1}{3200}$ of an inch, yet it sounds familiar, while to express the same measurement in the terms of mikron or millimetre would cause confusion and convey no idea of the size thus expressed.

A centimetre scale, ruled upon a polished metal surface by the United States Bureau of Weights and Measures for this Society, was adopted by its standard of microscopic measurements, after a long series of recorded investigations, requiring months of careful observation to determine its errors. Thus the Society has rendered available a standard of known value which may be used within certain restrictions by scientists throughout the country for the purpose of ascertaining, by comparison with the Society's authorized copies, the deviations of their own micrometers from the true measure. In

making corrections of micrometers ruled in the fractions of an inch it is still necessary to compare them with one of the standards in this country,—very few, and difficult of access,—or to make the necessary mathematical deduction required in a comparison with the standard centimetre referred to.

One of the most convenient and accurate methods in recording microscopical observations, desirable not only in legal but in all other cases, is by photo-micrography. Though photographic prints are rarely admitted in evidence, they may sometimes be used advantageously for the purpose of illustration and explanation. Occasionally original negatives are accepted in evidence, apparently under the general but mistaken belief that they could not be materially altered without more or less marring of the plate in such a manner as would render the change obvious to a casual observer.

Of late years much has been said in favor of cheap and simple microscopes, and the large complicated instruments have been severely condemned. One of the strong points brought forward in favor of the Continental instruments is their simplicity. Nevertheless, the fact remains that the fewer accessories with which a microscope is provided, and therefore the simpler its construction, the more limited is its field of usefulness. Certainly in the department of legal microscopy, the most perfect instruments and appliances known are a necessity if the work is to be properly executed.

The microscope itself, where only one is employed, should have all the requisite scales, and a mechanical stage provided with index for finding objects is a necessity. The cobweb eye-piece micrometer should be provided not only with the usual index and lines for measuring, but also scales for determining the angles of crystals. Polarizing apparatus with selenites is frequently required. A spectroscopic attachment is also essential. Where possible, it is more convenient to use different instruments for certain processes of an examination; such, for example, as the inverted microscope used in the chemical analyses already referred to. Not only should a complete photo-micrographic apparatus be accessible, but also cameras and lenses for ordinary photographing and copying, together with a fully-equipped dark room for the development and treatment of plates.

Thus equipped, and with the requisite skill, the modern microscopist may become a true *amicus curiæ* in the best sense of that much-abused term. It is true that an industrious and exhaustive search by all the means at our command may sometimes produce only negative results; yet in other instances there will be revelations which shall change the whole theory of a plea in civil actions, while in criminal causes they may become a terror to the guilty or a joy to the innocent. Much is illusive in all methods of scientific research, yet it has been found that microscopy can sometimes

"Hold the eel of science by the tail,"

when every other method of investigation has proved unavailing. Especially is this true of forensic microscopy; and the time has fully come when counsel and client, courts and juries, must and will give heed to its disclosures.